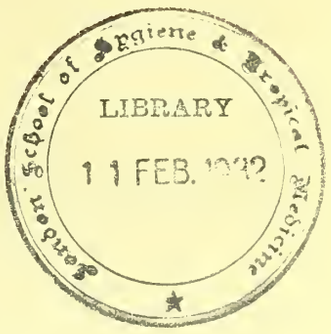
1893.

VICTORIA.



REPORT

ON THE

CHARITABLE INSTITUTIONS OF MELBOURNE,

BY

DR. GRESSWELL.

RETURN to an Order of the *House*,
Dated 2nd November, 1893, *for*—

A COPY of the Report to the Royal Commission on Charitable Institutions, by Dr. Gresswell, in regard to the Charitable Institutions of Melbourne.

(*Mr. Zox.*)

Ordered by the Legislative Assembly *to be printed, 2nd November*, 1893.

By Authority:
ROBT. S. BRAIN, GOVERNMENT PRINTER, MELBOURNE.
C.—No. 6.—[1s.]—7863.

APPROXIMATE COST OF REPORT.

	£	s.	d.
Preparation—not given.			
Printing (1,760 copies)	18	0	0

REPORT TO THE ROYAL CHARITY COMMISSION

ON THE

CHARITABLE INSTITUTIONS OF MELBOURNE,

BY DR. GRESSWELL.

Subject of Report.

Of the questions submitted to me relative to the Charitable Institutions of this metropolis—one, concerning provision for isolating infectious persons, has already been dealt with; the other, concerning the conditions under which persons are placed in those institutions, forms the subject of this Report.

It will be convenient to consider—first, the Hospitals; and, then, the Benevolent Asylums and institutions of like character.

Hospitals.

Essentials of hospital-management.

It has during recent years come to be recognised that charity, expended in the establishment and maintenance of institutions for supplying indoor medical relief, has in no small proportion of instances brought about results the very reverse of those which were anticipated, the treatment in such institutions of persons suffering from injury or from disease having so frequently resulted in accentuation of the mischief which those institutions were designed to alleviate, in contraction of other illness which the sufferer would in all probability have escaped at home, and, times out of number, in an unnecessarily fatal termination; and it is accordingly nowadays accepted that the aggregation of persons suffering from injury or from disease—with the view to the care and treatment of them—in large institutions cannot be justified unless the sufferers be supplied with the best available services of the medical profession and with the best available conditions for rapid and sound recovery.

Brief consideration may, perhaps, with advantage be given to some of the experiences upon which are based the foregoing observations as to the importance of wholesomeness of the conditions incidental to hospital life.

Evidence of need for wholesomeness of hospital conditions.

Of special interest in this connexion there is the reduction of fatality from cuts and rents of the body, accidentally or otherwise produced, which has followed the introduction of certain changes in the manner of treatment within recent years; for the *rationale* of this reduction has a direct bearing on the value to be placed on wholesomeness of hospital conditions. The fatality from many forms of wounds, of surgical operations, and of such internal rents as those accompanying childbirth has fallen in proportion to the care with which the cut and rended surfaces have been preserved free from infecting agents—agents which, for the most part, may be regarded as synonymous with minute disease-producing organisms (pathogenic micro-organisms). Proof of this may be found in a variety of statistical data. The clinical and other records for maternity-hospitals will serve in illustration, for puerperal illness and puerperal mortality have declined in those hospitals in proportion as the later methods of treatment—the sterilization-methods of asepsis and of antisepsis—have been adopted. M. le Fort has shown that the deaths among 800,000 women, delivered in European maternities before sterilization-methods were regarded of so much importance, were at the rate of 3·4 per cent.; whereas under sterilization-

(Puerperal disease before and after introduction of sterilization-treatment.

methods the rate has become smaller even than 0·5 per cent. The statistics relating to a few of these maternities may here be cited. At the maternity of Copenhagen the mortality from puerperal fever in the years 1850 to 1864 was 4·1 per cent.; but after the introduction of antiseptic treatment in 1865 it fell at once, until in 1870 to 1874 it was only 1·1 per cent. At the maternity in Paris the mortality 30 years ago was 9 per cent. or more; eight years ago it was only 2·5 per cent.; whereas during the years 1890–91, when there were 1,340 confinements, the maternal mortality was only 1·04 per cent., and there was not a single death attributable to puerperal fever. At the Imperial Maternity in Vienna the mortality from puerperal fever has fallen from 2·8 to 0·4 per cent. since sterilization-treatment was introduced. At the maternity in New York the mortality from puerperal fever has fallen from 6 per cent. in 1883 to 0·1 per cent.; and at the maternity in Boston City it has fallen from 4·5 per cent. to zero. During the last three years there has been only one death from puerperal fever in the maternity at St. Petersburg. So also at the general Lying-in Hospital, in York-road, London, where prior to 1887, when sterilization-treatment was adopted, the mortality from this affection, "always high, occasionally became fearful." At the maternity of Helsingfors the maternal mortality, which for years had been only 1·26 per cent., fell, after the introduction of sterilization-treatment, so far that among the 3,841 confinements, which have since taken place there, it has been only 0·60 per cent.; while cases of illness after confinement, which were at the rate of 12·10 per cent., fell in the latter period to the rate of 4·11 per cent.

(Results of wounds and of operations before and after introduction of sterilization-treatment.)

The contrast, thus presented in connexion with the natural rents attendant upon childbirth, is to be found also in connexion with other forms of wounds and with many forms of surgical operations, and to so marked a degree that, as with fever in cases of childbirth, so also with erysipelas, with pyæmia, and septicæmia in surgical cases, the cause of the complicating, and but too often fatal, affection is nowadays rigorously inquired into; whereas previous to the introduction of sterilization-treatment these affections were so commonly repeated that their occurrence was regarded as commonplace, and scarcely if at all preventable. These affections are now explained by the occurrence of certain kinds of micro-organic life at the seat of injury, it being all but universally accepted that, in proportion as certain kinds of micro-organisms are allowed access to cut or broken surfaces, so, according to the circumstances of the case, will puerperal fever, erysipelas, pyæmia, septicæmia, malignant œdema, tetanus, and certain other diseases flourish; and that in some cases the absorption of the products merely of the vital activity of such micro-organisms from the seat of injury into the system may bring about similar results.

Mode of action of sterilization-treatment.

Sources of disease-producing micro-organisms.

The question now arises as to the nature of the conditions which favour retention, cultivation, and distribution of these minute organisms. Semmelweiss, nearly half a century ago, showed that the poison of puerperal fever was transmitted to women in childbirth by persons engaged in the *post-mortem* or in the dissecting room; while the conveyance of this poison by persons attending on women in the condition just mentioned had been recognised many years before. Then Sir James Simpson showed that surgical fever was much the same as puerperal fever, and that the two probably depended on one and the same poison; while Lister proved the dependence of the former on micro-organic life. And of late years the micro-organisms concerned in pus- or matter-production (suppuration), in septicæmia, in malignant œdema, and in tetanus have been demonstrated in the superficial layers of many soils, especially of inhabited and of cultivated localities; and at least some of them, as also other infecting micro-organisms, no doubt flourish or at least retain their vitality on dirty surfaces, on dirty articles of bedding and of clothing, and in foul sinks and closets.

Best results in hospitals where sterilization-treatment accompanied by improvement of general conditions.

It will, then, cause no surprise that the best results have been obtained in those hospitals where sterilization-methods of treatment have been accompanied by measures directed to the removal of conditions such as those just mentioned—to the maintenance of cleanliness, and to the prevention of likelihood of carriage of infecting agents by persons attendant on the sick. The necessity for the adoption of these measures is indicated in many ways. At the Vienna and the Paris maternities a great reduction of mortality followed removal of general unwholesome conditions even before sterilization-treatment was adopted, the reduction in the latter case having been from a rate of 9·3 per cent. to a rate of 2·3 per cent.; and then, after the adoption of sterilization-methods, the rate fell to 1·1 per cent. The lowness of the maternal mortality in the hospital at Helsingfors before sterilization-methods were adopted—

only 1·26 per cent.—is attributed by Professor Pippingsköld to wholesomeness of the conditions in and about the hospital and to general cleanliness of habits of the people. The contrast pointed out long ago by Sir James Simpson—that, whereas 30 per cent. of the persons died who underwent certain forms of amputation in eighteen large hospitals during a certain period, the mortality from such operations for the same period in country practice was only 10 per cent.—was attributed to difference, not so much of treatment, but of conditions to which the patients were subjected, the conditions of country life being of a more wholesome character than those obtaining at that time in most hospitals ; and this explanation is confirmed by many experiences. Of the latter there may be mentioned the fact that the mortality from compound fracture of the extremities in the Boston City Hospital was reduced by more than one-half after the wholesomeness of the buildings had been improved, though the method of treatment was continued as before; and again the fact that with an army engaged in war septic disease is largely avoided if the men be treated in the open air, whereas that disease is but too common when the men are treated as they were during the siege of Paris in ordinary city buildings. No doubt the lowness of the mortality among women in childbirth generally throughout England, only 0·8 per cent. (Duncan), and that among the 11,000 women who were delivered in 1867 in 40 English work-houses, only 0·7 per cent., are similarly to be explained ; as is also the contrast observed by M. le Fort in the mortality among women delivered in Paris in 1873–5, according as those women were delivered—either, on the one hand, at their several homes by official midwives or in the licensed homes of midwives; or, on the other hand, in special maternities or in obstetric wards of general hospitals, the percentage mortality in these four sets of cases having severally been as follows, viz. :—0·18, 0·5, 3·1, and 4·1.

Necessity for prevention of infections.

The necessity for excluding from the hospital all conditions favorable to retention, cultivation, and distribution of infective micro-organisms must then be admitted. No justification can be advanced for tolerance of conditions under which wound-infections are facilitated. The same holds also of conditions which facilitate other forms of infection, such as granular conjunctivitis, tuberculosis, and ordinary infectious diseases.

Necessity also for certain chemical and physical properties of the air of hospitals.

But, over and above all this, there is the necessity for preventing unwholesomeness of the atmosphere arising from other conditions than the presence in it of disease-producing micro-organisms. In the ordinary process of respiration part of the vitalizing agent of the air that is breathed is withdrawn, and the vitalizing influence of the remaining portion of that agent is probably reduced, while at the same time the atmosphere becomes charged with matters possessed of poisonous properties. Some of the injurious effects of overcrowding and of insufficiency of ventilation are thus explained. Overcrowding and insufficiency of ventilation directly aid the transmission of infection ; but they also, independently of such infection, render the air of rooms in some instances actually poisonous, and in others of such a kind as to lower the vitality and reduce the power of resistance to processes of disease. There is much evidence to support these statements. Improvement of the ventilation of factories has been followed generally and almost at once by improvement of appetite, of colour, and of energy among the employés, and by a great reduction of the previous rate of sickness among them. There can be but little doubt that the overcrowding of the Hôtel Dieu of the last century—where at times 30 square feet only were allotted to a patient, and two, three, four, five, or even six patients in all stages of illness had to share one bed—was in large part the cause of the frightful mortality recorded against it, and at least in some part independently of the facilities afforded by such overcrowding for contracting specific infection. The fall of mortality among the French cavalry horses to one-ninth of what it had previously been, which years ago followed the increase of cubic space allotted to them, was no doubt the result, not solely of the reduction of opportunity for contraction of infection, but in part at least of a more vitalizing condition of the atmosphere. Prior to 1836 the yearly mortality among those horses was over 18 per cent., but on increasing the ration of air it fell in the next ten years to 6 per cent., and in 1862–6 it was only 2 per cent. A similar fall of mortality accompanied a similar change in connexion with the English cavalry horses. The reduction, also, of deaths from phthisis in the European and English armies and in the royal and merchant navies is no doubt not explained solely by reduction of the opportunities for transmission of micro-organisms from one person to another.

To all this add the fact that the excretions in cases of illness may be increased, perverted and rendered more dangerous—and the importance of securing a thoroughly wholesome atmosphere in and about hospitals, as a cardinal guide in hospital-location, -planning, -construction, and -management, will be admitted.

Guides towards securing wholesome hospital-air.

Some experimentally determined data, affording guidance in the accomplishment of this object, may now be briefly referred to. First, it may be observed that ozone—a peculiarly active form of the vitalizing element of the atmosphere—is found in special abundance in sea- and in mountain-air, and, though present over the suburbs of large towns, may be, and often is, almost or wholly absent towards the centres of them. Similarly, also, the amount of carbonic acid in the air—which may be taken as a rough criterion of the amount of combustion and decomposition going on—is found to increase from the suburbs towards the centres of large towns. Dr. Smith found in Manchester that in usual weather the air of the suburbs contained 0·029 per cent. of carbonic acid, while that of the central streets contained 0·04 per cent.; and almost precisely the same increase was found by Carnelly, Haldane, and Anderson at Dundee. Then, too, it has been shown that the composition of the atmosphere is largely dependent upon that of the soil. The soil of cities and of manured lands is an active scene of decomposition of dead organic matter in process of being resolved by countless minute organisms into simple inorganic bodies. The soil of city streets, as might be expected, is found to be more or to be less charged with micro-organisms, with organic matter, and with products of decomposition of organic matter according as the street from which it is taken is more or is less subjected to business-traffic. The dust of the most busy streets of Naples has been found to contain as many as a thousand million micro-organisms to the gramme, whereas the sand of the seaside may be almost bereft of such organisms. Dust from the streets of Naples was inoculated somewhat recently by Dr. Manfredi into guinea pigs. Disease followed in 73 per cent. of the animals inoculated; and among 42 of the animals thus diseased the micro-organism of pus, that of malignant œdema, of tetanus, of tuberculosis, or of septicæmia was found in as many as seventeen, these micro-organisms having apparently therefore existed in the dust used in the inoculations. To the same order of facts doubtless belongs also the special incidence of infantile diarrhœa on communities dwelling on soils that are moist, pervious, and polluted. It may be observed, too, in this connexion that, while no micro-organisms have been discovered in sea air and only 0·001 per litre on high mountains, 3·9 have been found per litre in the Rue de Rivoli (Paris), and 7·0 in St. Paul's Churchyard (London); and that the raising of dust into the atmosphere may, so to say, indefinitely increase the number and probably the kinds of them in the air—not merely of those concerned in decomposition and in putrefaction, but of those also that are concerned in the production of specific disease.

It will, then, be evident that these and like matters demand consideration when determining upon the measures to be taken for securing wholesomeness of atmosphere in and about hospitals. In the first place, accordingly, the site needs to be selected with due regard to cleanliness and dryness of soil, as also to wholesomeness of atmosphere dependent upon other conditions in the locality. Next, the buildings must be so related one to another, as also to elevations of surface and to erections at the time or likely in the near future to be constructed in the neighbourhood, that the sun's rays may fall directly upon the several compartments of the buildings and upon the several parts of the grounds; and that at all times there may be as complete perflation as possible of the grounds, particularly between the buildings. Thirdly, the buildings must be so constructed that indoor perflation may be readily and thoroughly supplied at any time, and be under complete control. Then, too, the cubic space allowed and the mode of ventilation must be such that only outdoor wholesome air will be supplied to each patient, and that such air, when once contaminated with any unwholesome exhalation or emanation, will be removed—not merely diluted—so as not to come within the respiration- or the wound-sphere of any inmate a second time. Means must be supplied also for readily removing, and for preventing as far as possible the lodgment of, all infecting agents, all material subservient to their development, and all fermentable matter. Regard should also be had to quietude of locality, and to cheerfulness of prospect.

In other words, the hospital-atmosphere must be as free as practicable from products of decomposition of organic matter, and must approach in composition, probably also in electrical reaction, as nearly as may be to the atmosphere over seas and elevated lands, the ward-air being maintained, however, as nearly as practicable

at a temperature varying with the nature of the cases under treatment from 50° to 60° F., and, with the latter temperature, at a degree of humidity represented by 70 to 80 per cent. of that required for saturation, more complete saturation being required, however, for certain special cases.

Neglect of hospital-conditions inexcusable.

It thus appears that there are not a few conditions which have influence on the wholesomeness of hospitals. They have, however, been so repeatedly and emphatically spoken of—and in this connexion the honoured name of Miss Florence Nightingale must ever be given a foremost place—that the hospital of to-day has come to present marked differences from the hospitals of even a comparatively few years ago; for, *though it be admitted that with the advance of medical science many classes of patients may be treated with success nowadays under external conditions of a most adverse character, and that neglect on the part of the physician, the surgeon, the dresser, the clerk, or the nurse is not to be excused, it has for some time been recognised that inexcusable also is neglect in matters affecting wholesomeness of the general conditions incidental to hospital life.*

Hospital reconstruction would, indeed, have proceeded at a still greater rate, if the importance of excluding infecting micro-organisms from wounds, from cuts, and even from naturally rended surfaces (such as those attending childbirth), and that of securing wholesomeness of atmosphere in hospitals had been more generally and completely understood, and the nature of the responsibility resting on those who undertake the establishing and managing of hospitals to secure wholesomeness of conditions throughout had thus been more readily gauged. *In order to meet the requirements of modern hospital hygiene demand is made for the conditions which have been enumerated above. Those are the conditions to be taken as cardinal guides in locating, in planning, in constructing, and in managing hospitals of every kind.*

Before proceeding to examine the conditions of the hospitals of this metropolis, it may be well, with the aid of what has already been said, to consider some of the particulars to be borne in mind in locating, planning, constructing, and managing a general hospital, ranging them under three headings, viz., large general hospitals, large general hospitals of gradual growth and small general hospitals, and finally some particulars of management.

A.—Large General Hospitals.

1. *Size and Situation of Hospital-site.*

Area of site.

In the first place, it is necessary to arrive at a fairly definite conclusion as to the size of the hospital site required. It will be impossible here to take up the numerous considerations that necessarily enter into a calculation of this sort; but it may be stated that for a general hospital it is not advisable to have more than 80 patients to the acre, and that the wards, as well as other buildings, need to be cleansed throughout at frequent intervals, and therefore on such occasions to *lie fallow*. Having arrived at a conclusion as to the size of the site, the next point to consider is the location. In this matter, questions of expediency, no doubt, must but too largely be taken into account. The site should, however, be selected specially for wholesomeness of atmosphere; and in attempting to secure, as far as may be, this condition there are cleanliness and dryness of the soil (both of the site itself and of the surrounding lands), together with freedom of perflation of the district in general, to be borne in mind. The soil should be, or should admit of being readily made, clean and dry. It should admit also of being readily maintained in such condition. There should be no serious difficulty in the way of thoroughly surface-draining the whole of the site, or of preventing stagnancy of any ground-water, which, moreover, should not, if practicable, be allowed to rise to within about 12 feet from the surface. It is necessary therefore to avoid, for instance, ravines, marshes, made land, manured lands, refuse- and excrement-depôts, cemeteries, noxious trade-establishments, abattoirs, factories, and crowded localities; and, with the view to preserving as far as possible wholesomeness of atmosphere in after years, to reserve free of large permanent erections an ample margin —aeration-zone—all round the site.

Location.

2. *Shape of Wards.*

Shape of wards.

The patients should be accommodated, in small numbers together, above the ground-level in wholly independent structures (pavilions), exposed throughout to free perflation, and each constructed after the general shape of an oblong or a circle, it being understood that very small hospitals and certain special forms of wards are not for the present under consideration. The oblong pavilion will alone be dealt with here, reference in the first place being made to that of only one floor; though, it may be stated, the circular ward is probably more readily and completely ventilated and perflated, and more readily and uniformly warmed.

3. *A One-floored Pavilion of Maximum Size.*

Size of pavilion.

The objects to be had in mind in determining the maximum size of a pavilion of a *general* hospital are isolation of patients, promptitude of removal of infective and fermentable matter, and efficiency of the nursing. It is nowadays generally accepted that, if the nursing in one floor of a pavilion is to be conducted under only one head-nurse, it is best to accommodate not more than twenty patients in it at one time. If there is to be, as is the general custom, but one head-nurse to one ward—if she is to keep herself fully conversant with the history of each of the patients, and with the condition and progress of each while under her charge, so as herself to be in a position to give every information and assistance to the resident and to the visiting

physician or surgeon, and if she is to give the necessary directions to and maintain the necessary discipline among the nurses under her charge—twenty patients will fully engage her attention. Pavilions accommodating on one floor 30 and even more patients have, it is true, been constructed. My own experience is that this number is excessive; and, as a matter of fact, in several important hospitals built during the last few years the number has not exceeded twenty. A head-nurse, when supervising the nursing of a large number of patients may, no doubt, for a few years charge her memory to the extent required, and at the same time retain the independence of mind necessary to her usefulness; but I do not hesitate to say that, if she makes the attempt for more than a few years consecutively, either she or the patients under her charge will suffer. A head-nurse cannot for long do justice to her office if she is in charge of more than about twenty patients. Of course, if a ward is to be placed under the management of two or more independent nurses, the case is altered; but it may be questioned whether such mode of management would generally work satisfactorily. It remains to be added that two or four of the twenty beds are best provided for separately in one or more independent rooms, so that it will be convenient, in what follows, to refer to the main ward and to the separation-ward or -wards.

Not more than 20 patients in one ward.

Internal dimensions of ward.

The several internal dimensions of the main ward may now be considered. The basis upon which these are fixed relates, not simply to questions of stability of construction and of such like matters, but to questions also of indoor perflation and of ventilation. Air once contaminated or impaired in its vitalizing influence must as soon as practicable be removed, and therefore replaced by wholesome air from out-of-doors, and this without either unduly raising the temperature of the air of the ward—a matter to be borne in mind in hot climates—or causing injurious draughts by admission of rapid currents of air at a low temperature; and, in the second place, provision must be made for securing efficient indoor perflation of the ward at frequent intervals. These objects might best, perhaps, be attained in a long narrow ward, containing only one row of beds, placed with their long axes either parallel or transverse to that of the ward. But the required conditions as to perflation and ventilation may, under most circumstances of climate, be secured, as far as need be, in a ward in which there are two rows of beds arranged with their long axes transverse to that of the ward; and this arrangement, involving, as it does, less expense in nursing and in general management, is that which is generally adopted, and that which will alone be here considered. In order to secure ready perflation of the ward it appears that the width should not exceed 26 feet. With the arrangement of beds just mentioned it should not be less than 24 feet, and for children not less than 22 feet. If clinical teaching is to be carried on in the wards, or if centrally placed heating appliances are to be adopted for the ward, the width should be 26 feet for adults and 24 feet for children. The height must not in any case be less than 10 feet, and, in so far as ventilation is concerned, it need not exceed 12 or certainly 13 feet, though additional height is no doubt of advantage in certain cases. The square or floor area for each patient should certainly not be less than 100 feet, one side of it, in the direction of the long axis of the ward, and spoken of as linear wall-space—though better, perhaps, as wall-line—measuring at least 8 feet. If much clinical teaching is to be conducted in the ward, or if the whole ward is to be devoted to acute surgical cases, or if the hospital is to be in a hot climate, at least 20—some say 40 or even 50—additional square feet should be provided for each patient. The amount of cubic space allowed per patient in different general hospitals is very various. Allowing only 12 feet for height it is not less than 1,200 feet in most hospitals recently built, not less than 1,500 feet in wards for severe surgical cases, and not less than 1,800 feet in wards devoted to women lying-in or to infectious patients. It is necessary to determine the amount of cubic space to be allowed per bed, in order that the placing of the beds, of the windows, and doors may be properly carried out. The length of the ward, as calculated on the above data, needs to be added to in order to allow for an interval of 5 feet between each end-bed and end-wall; also for a doorway, $4\frac{1}{2}$ feet wide, if the introduction of one be practicable, in each side wall; and for an interval of 3 feet between such doorway and the bed on either side of it.

(Width.)

(Height.)

(Floor-area.)

(Wall-line.)

(Cubic space.)

Ward-offices.

The pavilion—consisting of the main ward and separation-ward or -wards—is not, however, complete without other compartments, generally spoken of as ward-offices. Of these there are—(*a*) the head-nurse's room; (*b*) a day-room for convalescents; (*c*) a ward-kitchen and -scullery; (*d*) a store-room or a cupboard for clothes required at short notice for the patients; (*e*) a store-room or a cupboard for ward-linen; (*f*) a store-room or a cupboard for brooms, brushes, and like things; (*g*) a room in which clothing and bedding may be aired and warmed; (*h*) a clinical room in the case of a hospital where clinical teaching is conducted; (*i*) in connexion at least with wards devoted to severe surgical cases, to women lying-in, or to infectious cases, a room in which a special over-all cloak may be put on by visitors; (*j*) an ablution-office; and (*k*) a closet-office. All but the two latter of these compartments are best built, along with the separation-ward or -wards, as one block (the *office-block*), attached directly or by means of an air-disconnecting lobby to the entrance end of the main ward, the compartments of the block being arranged on the two sides of a passage, which—8 or, better, 9 feet wide—should conduct directly to the entrance of the main ward.

(Situation of ward-offices. The office-block.)

(Details of the office-block.)

The store-rooms above named should be entered through an external wall by doors extending the full height of the room. Each of the other compartments should open independently into the passage just mentioned by a door, which ($3\frac{1}{2}$ feet wide) should either extend as near as practicable to the level of the ceiling of the compartment, and therefore of that of the passage, or be supplemented above by a window so extending and freely opening. The block consisting of the several compartments mentioned admits of being arranged after different plans. It, with its central passage, may be arranged in the form of a square of about 40 feet in the side. It is convenient also, as suggested by G. Smith, to have in it one or more small rounded recesses, completely open either to the exterior or to the passage, for a small coal trolly, a food trolly, and a dirty-linen trolly; and the question of providing closet-accommodation near to it for nurses and for convalescents requires consideration. Each of the compartments needs, of course, to be separately lighted and separately ventilated. There remain for further description the ablution- and the closet-offices for the patients. These should be provided as two independent buildings, though in some recently built hospitals they have been combined to form one independent building. In any case, each building must be connected by a thoroughly cross-ventilated narrow passage with the further end of the ward, and, in the case of two buildings, one with one corner of it and the other with the other. This passage or lobby should be 6 to 12 feet long and 5 feet wide, and be closed at each end by a self-closing door, allowing, in the case of the ablution-office, of the ready removal of the bath into the ward. In one or both sides of it a doorway may be introduced for providing access from out-of-doors for a scavenger or cleaner. The passage must not be used for storage of any articles whatever. The floor of each office

Ablution- and closet-offices.

(Their situation.)

(Their floors.)

must be impervious, rock-asphalt or a metal-tray being serviceable for securing this object. It should be gently graded throughout to one outlet, so as to be self-draining; the outlet discharging directly by means of a properly-trapped pipe through an external wall on to a short open gutter, and thence, if practicable, into an underground drain; so that the floor should be at least several inches above the outdoor ground-level. (Their compartments.) Each office will need to be divided by partitions (consisting of impervious material, such as painted iron) into compartments devoted to various purposes; and the partitions, which should be short by at least a foot both of floor and of ceiling, may be in the form of vertically hinged sheets, so arranged that all the compartments may be thrown into one. It is imperative also that every part of each office and of the fittings contained in it be directly and readily accessible for cleaning purposes. The ablution-office must be furnished with two (or, better, with three) such compartments—one for a lavatory-table or -slab for two to four washhand basins, and the second for a movable plunge-bath. The latter should be on noiseless (Plunge-bath.) wheels; its position in the office should be such as to render it freely accessible for the nurse from both sides and both ends, and its contents should be discharged over the floor-outlet above described. The floor, the partitions, and the doors must be so arranged that the plunge-bath may be readily wheeled from the office into the main ward. The closet-office must be divided into three or four compartments, so as to provide for two separate closets, for a urinal in the case of a male ward, and for a slop-room, in which ward-utensils of all sorts may be emptied, washed, and kept, and through an external wall of which a louvred cupboard may be made to project out-of-doors for utensils containing evacuations for medical inspection. If earth- (Construction of earth-closets.) closets are to be adopted, the necessity for ready accessibility of every part (especially of the sides) of them must be borne in mind; the space beneath the seat—the middenstead—should be as open as possible in front and at the sides; the hind wall of the space (if the receptacle is to be removed from the rear) being an external wall; the floor of the middenstead must be at least 3 inches above the ground outside, be smooth, hard, and impervious—conditions already, however, mentioned as being required for the general floor of the office. The middenstead must be so shaped that the receptacle will not be brought into contact with any part of its seat or walls, that there will be an interval of 3 inches between the front of the orifice in the seat and the posterior surface of the front wall of the receptacle, and an interval of not more than 1 inch between the seat and the upper edge of the receptacle. A strong guide should be made to project into the middenstead from one of the walls or from the seat in such a manner as to facilitate the placing of the receptacle in its proper position. Access for removal of the receptacle may be provided from either the front or the rear; and the receptacle itself needs to be impervious and to admit of being readily handled, lifted, emptied, and cleansed. If water-closets be adopted, the greatest care is needed in constructing them. Urinals also need (Water-closets and urinals. V. infra.) particular care if wholesomeness is to be secured.

Then, too, there are the verandahs, which, in a hot climate, are almost necessary adjuncts to the Verandahs. pavilion.

It may also be stated here that ready access to the roof must be provided, in order to facilitate Access to roof. examination of chimneys, ventilating flues, roof-coverings, gutters, water-tanks, and so on; and that such access must be by external staircase or ladder, and not by manhole through any of the ceilings of the pavilion as above described.

Attention may now be given to the materials of which the ward is to be constructed. It is needless Materials of ward. (Wood and canvas.) to state that neither wood nor canvas is suitable for permanent wards. These materials absorb noxious exhalations, and retain infection in a notable degree. In localities characterized by considerable variations of weather, in spite of all the attempts that have been made to overcome the difficulty, it has not been found possible to maintain the required degree of constancy of temperature in wards constructed of these materials, even with the walls and the roof double and with the intervening air-space either on the one hand closed in winter and freely perflated in summer, or on the other hand filled with materials specially selected for the purpose. It is impossible to prevent shrinkage of wood or of canvas, and consequent opening up of joints and seams. It is difficult to render and expensive to maintain these materials smooth, hard, and impervious at the surface as they should be; and it is impossible to put them together in such a manner as to be sufficiently stable to afford in stormy weather a proper sense of repose and of security to the inmates. And they are readily combustible. Hence it is that brick, stone, or like material is used by (Brick, stone.) preference; though iron wards, constructed with double walls as described above, have, it is said, been (Iron.) used with a certain measure of success.

In all cases the construction must, as far as practicable, be such as to exclude the entrance of air Exclusion of ground-air and -moisture. from the soil (ground-air) and of water from this and from other sources. The importance of making special provision for the exclusion of ground-air and -vapour will be evident when it is borne in mind that the soil of and about the site of the building contains a large amount of water, and may contain a large amount of organic matter, which may, indeed, have passed into it from a distance either by drainage or as a result of the action of atmospheric pressure or of winds; that in such cases it will, in all probability, contain hosts of micro-organisms (many of them capable of producing disease), and be a seat of active decomposition; and that equilibrium as between dense outdoor air and rarefied indoor air is partly brought about by indraught of air from the interstices of any pervious soil beneath the building. The soil about the hospital, it may here be remarked, should perhaps be sterile; and if it contains organic matter it should be constantly under cultivation. In order to prevent entrance of ground-air and of the vapour of ground-water into the pavilion, the whole of the surface of the ground under the latter must be impervious—a condition best secured by means of rock-asphalt laid on a layer of concrete, the surface just referred to having been first raised above that of the surrounding ground. This asphalted surface may form the floor of the ward if the asphalt layer is sufficiently thick and is continued on all sides through the substance of the walls. It is cold, however; and, for this and other reasons, the floor should be inserted a few inches above the asphalt or raised a few feet above the general level on arches, though in this case also it is advisable to render the surface beneath impervious. In either case, the space under the floor must be kept dry and clean, and at all times well perflated. Having regard to the necessity for these conditions, it will be seen that the construction of (Basement-chamber to be avoided.) a basement-chamber is to be avoided, owing to the expense of rendering the floor and walls both water- and air-tight, to the difficulty of maintaining the air of the chamber wholesome, and of draining the chamber when subjected to the hose. Indeed the surface of the ground under the floor should be raised above the surrounding level, and be so formed and graded as to be self-cleansing under the hose, any space required under the floor for accommodation of pipes provided for heating or for other purposes being obtained by raising the floor to the extent required above the ground. If a small basement-chamber is required for the

warming apparatus, it should be constructed outside the building-line of the ward. And if a large basement-chamber under the ward cannot be dispensed with, the conditions above-named must, as far as practicable, be complied with. In such a case, if the chamber is not of a great depth, the required condition of floor and of walls may be obtained by introducing a continuous and impervious layer, consisting, for instance, of rock-asphalt (in the form, in its entirety, of a cistern), and continued at its upper edge outwards through the entire thickness of the walls at a level of a few inches above the adjoining ground; or, as far as the walls are concerned, imperviousness to water in the soil may be obtained by the formation of a well-drained *area*, descending a few inches below the level of the floor of the chamber, the impervious covering on the floor of the chamber in this case being continued directly outwards through the walls. The chamber must, moreover, be as well perflated as practicable; and, even so, it should not be in direct communication with any part of the ground-floor, or, as already intimated, be used for accommodation of patients. If the foundations be constructed of such materials as brick or stone, it will be necessary to introduce an effectual damp-proof course in the walls, a few inches above the level of the adjoining ground, and beneath that of the lowest of the materials used in the formation of the floor. The roof, windows, and doors must, of course, be so arranged as to afford protection against wet. In order to prevent dampness of walls from other sources than the soil, it is necessary to attend carefully to the mode of construction of the upper courses, especially in the case of parapet-walls; and it may be necessary either to place on the external face or in the substance of the wall a layer of impervious non-decomposable material, or to build the wall hollow.

(Construction of basement-chamber.)

(Damp-proof course.)

Exclusion of wet from other sources.

Level of floor.

The under surface of the floor should be at least 6 inches above the ground. This condition is required for several reasons, of which there may be mentioned the need for the floor-space admitting of being readily cleansed and perflated, and, unless there be already sufficient fall, for providing such fall for the low-level waste-pipes from the floor-tray of the closet- and ablution-offices, and from the floor of other compartments which are graded for self-draining, as will allow of proper trapping of those pipes and proper air-disconnexion between them and any outdoor drain into or on to which they discharge. Perflation of the floor-space may be provided for by introducing gratings in each of its walls, and it may be increased by means of flues extending vertically from the space to above the roof, and fitted externally with fixed cowls. It is best, however, for many reasons to raise the floor several feet above the ground on arches.

Construction of walls, floor, roof, and ceiling.

The walls may be built either solid or hollow, impervious bonds being used in the latter case; and they are best built of materials as impervious to moisture as can be afforded, as free as practicable of deliquescing salts, and in as uniform a manner as possible. Hollowness of the external walls aids in preserving dryness of their inner portions, and also in maintaining coolness of the indoor air in summer and warmth of it in winter. The floor of the cavity of each wall should be at a level below that of the damp-proof course, and be graded so as to be self-draining to one outlet, and the cavity should be so provided with covered openings that it may be readily perflated at any time; otherwise the cavity of each wall should be closed. Expanded metal lathing may with advantage be used instead of wood in partition-walls. A good floor may be formed of concrete laid between and about an iron framing, and covered by asphalt or by boards of hard wood. Skirtings are best formed either of metal in the shape of long triangular prisms (and fixed by screws), or of asphalt; and if they are formed of wood particular care is to be taken that no empty space is left behind them. The roof should be pitched, and its framing be lined. If the lining presents an impervious lower surface, it may in some localities take the place of a ceiling. If it has not such condition of lower surface or if the indoor temperature would otherwise be subject to too great alternations of temperature, a ceiling should be introduced; and, with a pitched roof, the ceiling also may well be pitched to aid in ventilation. Any space left between ceiling and roof must be absolutely cut off from each of the compartments of the pavilion, must be thoroughly open to perflation without admitting birds or direct or wind-driven rain; and, if of large dimensions, must be readily accessible from out-of-doors, and admit of being readily cleaned. The ceiling may be formed of cement or of hard plaster, on wire-cloth netting, and oil-painted. The roof-covering must be self-draining, must be readily accessible from out-of-doors, and allow of ready access to all its parts for inspection; but, though made thus accessible, it must not be used as an ambulatorium, unless the foul air and gases issuing through it from chimney-stacks and ventilating outlets are guarded against. All conduits conveying hot air, steam, hot or cold water should as far as practicable be exposed and readily accessible, no part being embedded, unless unavoidable, in any wall or floor.

Precautions against fire.

Possibilities of fire need of course to be carefully considered when determining upon the mode of construction of chimney-shafts, *i.e.*, as to materials and thickness of their walls, as to height to which they are to be carried above the roof, as to condition of their internal surfaces, and as to the relation of them of fire-grates and of hearths to combustible materials (such as wood) or to good conductors (such as iron); upon the mode of construction of pipes for heating by hot air, by steam, or hot water, and the relation of them to combustible materials; upon the mode of construction of the roof in case chimney-shafts or hot-air flues are brought into direct relation with it; upon the mode of construction and upon the location of lighting appliances, and so on.

Internal surfaces.

The internal surfaces of the floor, walls, and ceiling of each compartment, no matter how small the latter may be, must be of severe simplicity and as few, as impervious, as smooth, and as hard as practicable—junctions of wall with wall and with ceiling forming curves of at least 4-ft. radius; ceilings if practicable being arched; windows and doors, and their frames, as also any chimney-shafts introduced into any wall, being as nearly as practicable flush with the general surface of the wall; and the whole of the interior admitting of being readily washed or hosed down. The best internal surfaces are obtained by the use of glazed brick or glazed tile, joined by the best cement, of glass, of asphalt, or of cement (or indeed hard plaster) painted when dry in oils and then varnished; and the best colours for the average of patients are light-green and light-blue. Distempering is to be avoided. Bare porous brick, whitewashed brick unless frequently whitewashed, and bare plaster should not present at any internal surface. The floor-covering may be formed of closely and finely grained hard and well-shrunken wood, tongued and either ploughed or grooved (screwed down over gas-pipes), and rendered smooth and impervious when thoroughly dry by such a substance as paraffin; or it may be formed of asphalt laid either in the manner already mentioned or on roughened boards. In the latter case the floor may be graded to one outlet to facilitate cleansing under the hose, and a dado continuous with the covering of the floor may be formed of the same material.

Windows.

The windows need to be so situated as to provide ready means for perflating the ward, and to prevent the necessity for placing the beds either end on to a window or broadside to a window or to a wall, unless it be at a distance of 5 feet. These conditions may be met in the main ward by inserting the

windows in the side walls in such a manner that each window on the one side will directly face a window on the opposite side, and that either one or two beds may be placed to each window-pier. If 8 feet of wall-line are to be provided per bed and 3 feet in width of glazed surface in each window, then, with one bed to each window-pier, the latter, together with the portions of window frames adjoining it, will be about 2 feet broader than the bed—a difference which should not be reduced in any case. If two beds are to be placed to each window-pier it is best to allow at least 9 feet of wall-line per bed, and to place the two beds 5 feet apart. As already stated, an interval of 5 feet is to be allowed between each end-bed and end-wall; and it is well in the side-walls corresponding to this interval to insert a narrow window. It is well also to insert in the end-wall a door-window (sash-door) facing, and of the same width as, the main entrance door. For facilitating perflation, the windows should extend from about 2 or 3 feet above the floor to a point as near the ceiling as practicable; or, if not made of such height, they should each be supplemented above by an additional window so extending and consisting of one sash hinged on its lower rail, and of a frame furnished with glazed cheeks, and allowing the sash to be inclined inwards and fixed at any angle, varying up to 90°, with the wall. Also, the main entrance door, the door-window facing it, and the lateral doors, if not extending the full height of the ward, should each of them be at least 9 feet high, and be supplemented above by a window extending as near as practicable to the ceiling, and opening after the fashion just described. If all the windows were made in the form of door-windows, the means for perflation would probably be as complete as could be obtained in a pavilion constructed of such material as brick or stone; and there seems to be no reason why such readiness of perflation should not be supplied, particular attention being given to the exclusion of wet and to the prevention of noise in windy weather. All windows must admit of being securely fixed, otherwise, in windy weather, acute illness, from which recovery might reasonably be expected, will be more severe and may even end fatally, and convalescence will generally be seriously retarded.

(Opposite windows.)
(Windows in relation to beds.)
(End-wall window.)
(Shape of windows.)
(All windows in form of doors.)

The amount of glazed surface to be supplied must be calculated with due regard to the necessity for sufficiency of light and of warmth in winter, and for sufficiently subdued light and coolness in summer. With one layer of glass in a temperate climate it is well (T. Thorne) not to transgress the limits of 1 square foot of glass to every 60 or 80 cubic feet of space of the ward, thus in the two cases severally allowing 20 and 15 square feet of glazed surface for every 1,200 cubic feet of space of the ward; but the kind of glass, the thickness, and the number of separate layers of it must be reckoned with in determining upon the precise amount of glazed surface to be allowed. Window-frames may be of iron, if not too much exposed to the sun; they, as also door-frames, should be made flush indoors with the internal surfaces of the walls in which they are inserted. The windows should consist of vertically sliding sashes, of laterally hinged sashes or panes, or of sashes or panes hinged by the lower rail so as to open downwards into the ward, the first form presenting, however, the disadvantage of requiring for the balance-weights boxed frames, which cannot be readily kept clean. The interior of such boxed frames should be readily accessible for cleaning purposes. If the vertically sliding sashes be adopted, they should be of such size and so arranged that one-half of the window, in equal parts at top and bottom, may be opened; and the lower rail of the lower sash as well as the sill should be of such depth as to allow the sashes to overlap to the extent of 4 inches at the meeting rails for admission of air, when the lower rail is not above the top of the sill.

(Amount of glazed surface.)
(Window-frames.)
(Shape of windows.)

Every compartment of the pavilion, no matter how small it be or to what purpose it be put, should, if practicable, admit of being subjected, whenever desirable, to the direct rays of the sun. And provision should be made for subduing the light, and for rendering the temperature indoors as equable as may be, by recourse to blinds, outer shutters, verandahs, ceilings, badly conducting roof-linings, asbestos and differently coloured paints, extra-thickness and hollowness of outer walls, and so on.

Access of sun's rays to each compartment.

Attention may now be given to the ventilation and perflation of the several compartments of the pavilion. Automatic ventilation—and the same may be said of ventilation wholly dependent upon artificial methods—is insufficient without creating draught for supplying such freedom of play of air-currents over the internal surfaces of the room and over the exposed surfaces of the articles of furniture as to remove in any notable proportion the vapours that condense on them, or for effecting *complete* removal of air from a room, especially either of the heavy and vitiated air which tends to accumulate towards the floor or of the lighter air which tends to accumulate towards the ceiling. If the term *ventilation* involves the absence of air-draught, then clearly it must not be regarded as including the processes which depend on air-draught for their efficiency. The latter are accordingly spoken of as processes of *perflation*. For maintaining wholesomeness of indoor air it is necessary, as intimated above, to provide for perflation as well as ventilation; and the two processes, though not distinguishable in all cases with nicety one from the other, may here be considered separately.

Perflation and ventilation.

Much has already been stated as to the means to be adopted for securing *perflation*. Reference, for instance, has been made to the advisability of so placing the windows as to render them opposite, and so, too, the doors—*i.e.*, in every compartment where this arrangement can be carried out. It is further necessary in the wards (as also in all sleeping-rooms) to provide in the external wall behind each bed one horizontal hole (skirting wall-hole), about 150 square inches in sectional area, making the lower internal surface of the hole as nearly flush as may be with the upper surface of the floor, and fitting each with an easily adjustable appliance for opening and closing; and, in the case of *each other compartment* of the pavilion, to provide similar holes, presenting a sectional area on the basis of 80 square inches to every 250 cubic feet of space, and to distribute them among opposite and, if practicable, among all of the outer walls. There must in any case be two such holes in each side-wall of the lobbies to the ablution- and closet-offices. A similar hole is required in the hind wall of the middenstead of any earth-closet that may be introduced; and, if the walls of the middenstead be formed as open as practicable, means must be supplied for at once opening and closing this hole. It is well, also, if the ceilings are not strongly pitched, to provide in the main ward and in the other compartments small horizontal wall-holes (wall-plate holes), 9 inches by 5 inches in area, in the outer walls just beneath the wall-plates, or corresponding structures, at intervals apart of about 10 feet. The mode of construction of these different wall-holes needs special description. The internal surfaces of every wall-hole must be formed by some continuous lining, fixed immovably to the substance of the wall, and made smooth, hard, and impervious, so that the lumen of the hole shall not communicate with any space in the substance of the wall. Each of the skirting-holes should be furnished externally with a fixable or dead-weight cover in the form of a grating, hinged above so as to be easily pushed out from indoors for cleaning purposes, and internally with a cover of such a form as to allow

Perflation-methods.
(Skirting wall-holes.)
(Wall-plate holes.)
(Construction of wall-holes.)

of the indoor opening being readily closed in varying degrees as required. The latter cover might be a sheet of metal, hinged along its upper edge, or it might be given the form either of doors *hung folding*, or, if made so as to be readily cleaned, of a slide. Each of the wall-plate holes should be furnished externally with a hood, hinged above, and opening downwards through a mouth protected by a grating. It will, of course, be understood that the frames—whether of the gratings, of the folding doors, of the slides, or of other such appliances—must not project into the lumina of the holes for which they are provided.

Ventilation-methods.

Ventilation, it is needless to repeat, must be as complete as possible; and no allowance is to be made for passage of air through the substance of the walls, seeing that the latter, if not impervious throughout, are to be rendered as nearly impervious as practicable at their internal surfaces. Elaborate plans have been devised for artificially supplying fresh air at a certain temperature and at a certain degree of humidity to each patient by means of propulsion and extraction. Artificial propulsion, however, has but too often given rise merely to the driving of columns of air direct from inlets to outlets, and to the agitation of the air of the compartment along the lines of those columns ; though, when the inlets and the outlets have been abundantly and judiciously distributed, this method of ventilation has been successful while the appliances have remained in working order. Artificial extraction, especially when combined with artificial propulsion, has been more frequently attended by success, but it has only too commonly failed. More

(Air-inlets.)

automatic methods, accordingly, are to be preferred, and mention may now be made of some of these. Air may be *admitted* either (as originally suggested by Whitehurst, and later by Tobin) by means of shafts extending from the outer faces of the external walls (the walls proper or the doors inserted in them) horizontally inwards and then vertically upwards on the inner face of the walls, or (as more recently suggested) by shafts extending obliquely upwards and inwards through the external walls, in either case to a uniform height of between 6 and 7 feet from the floor, and terminating in the former case in a horizontal, in the latter in a vertical opening ; or it may be admitted (as originally suggested by Désaguliers), by shafts * extending from the exterior—and, when required, from a very considerable height, if the indoor terminal portion of the shaft be properly constructed—through or about some heated apparatus situate in the wall, on or near to the inner face of the wall or in the central line of the ward, and delivering into the ward at any level, varying with the situation of the indoor opening up to 6 feet from the floor. With the Whitehurst method, it is as well not to construct the shaft through a window, for the down flow of air (experienced at the inner face of the latter when the outdoor is colder than the indoor air) may deflect the incoming air so rapidly as to give rise to strong down draught. With the Désaguliers method—that of heat-suction inlets—the air may be admitted into any room, no matter what be its shape or what its relation to other rooms, and, as already said, from a very considerable height. The air in any case must be taken from a wholesome outdoor source, at least 3 feet above the ground, and at a distance, it may specially be noted, from surface-drains, from openings into underground drains, from closets, and the like. The shaft must admit of being readily and effectually cleansed, and must not communicate with any spaces in the substance of the wall. If it be more than a few feet in length it must admit of being readily removed in order to be cleaned, that portion of it, however, which passes through the wall being made part and parcel of the wall itself by being attached to it on all sides by cement or other such material. If it be merely an oblique shaft, extending upwards and inwards from the external to the internal face of the wall, there should be at least 3 feet in the vertical direction between the levels of the outdoor and indoor openings ; and its internal surfaces should, as described for other wall-shafts, be formed of the substance of the wall itself, well rendered in some impervious material. Loose shafts should not be placed within wall-shafts, as the interval between the two serves as lodgment for dust and other objectionable matter ; and noise and discomfort to the patients arise when the loose shaft is shaken by the wind, a matter which needs consideration also in planning the covers to be placed over the ventilating and perflating openings. The interior of the shaft must in all cases be continuous, smooth, hard, and impervious. The outdoor opening of the shaft should be covered with a fixable or dead-weight grating, hinged in such a manner that it may be readily pushed outwards from indoors; and the indoor opening should be furnished with an appliance for regulating its size. In the case of the oblique shaft with vertical opening this appliance may be in the form of a flat cover, hinged below, and admitting of being fixed at different angles with the wall as required ; and, in the case of the vertical shaft with horizontal opening, such a cover must be hinged to the side of the opening which is furthest from the wall. In any case it must be so arranged that there will be no obstacle to the insertion of a cleaning rod and mop into the shaft, and no deflection downwards of the air as it

(Air-outlets.)

issues at the indoor opening of the shaft. Air should be *extracted* by means of shafts (ceiling-roof shafts) extending vertically through the roof from the centre or the longer central line of the ceiling or roof-lining to a point about a foot above the roof, each shaft presenting a continuous smooth, hard, impervious interior, and being fitted at the upper or outer end with a fixed cowl of good pattern and at the lower with some heating appliance. The shaft must be vertical from end to end; the plan frequently adopted, of making it vertical for a short distance from the ceiling and then horizontal in two opposite directions to the exterior, is altogether wrong. The heating of the lower end of the shaft is required for maintaining an outflow of air at all times, even when the outdoor air is only very slowly moving, and generally to facilitate the flow. It is of particular importance in the case of the ablution- and closet- offices for the prevention of likelihood of suction of foul air from those offices into the main ward. It may be obtained, for instance, by burning gas at one or more jets placed directly under the shaft, or by extending a special gas-flue or a chimney-flue through the shaft, the introduction of bare metal into the flue in either case being avoided, and the upper or outer openings of the two outlets being separately and independently cowled. It should here be mentioned that, in order still more effectually to prevent likelihood of suction of air from the ablution- and closet-offices into the main ward, it is well not only to heat the outlet-shaft but also to warm the office generally to a temperature above that of the main ward; and here it may be remarked that the ablution- and closet-offices require to be warmed for the safety of the patients using them. Arnott's valves properly inserted into the chimney-shaft close to the ceiling, act well as outlets when there is sufficient draught up the chimney ; but they need constant attention and frequent repair or renewal. A chimney-shaft—if properly cowled above, furnished also below with means such as a gas-jet, a lamp, or a hot-water pipe-coil, by which it may be warmed when the fire is not required, and, in addition, frequently cleaned—constitutes an active outlet as long as the air within it is warmed or the outdoor air is appreciably moving. It abstracts the air from a considerable portion of a small room, and, if supplied with Arnott's valves, from by far the greater portion of it.

---

* *Vide* footnote to p. 12.

It may here be remarked that the gas burnt at an ordinary jet consumes as much air as two or three adults ; and that, unless the products of combustion be delivered at once into the outer air, the gas jets must be allowed for in computing the amount of cubic space required for the ward. It must not be supposed that the inlets above suggested unless heated will under all conditions of weather supply air without draught. Indeed, with a strong wind it is not uncommon to find Tobin shafts on one side of a room acting as inlets and those on another as outlets, there being a strong current of air from the one to the other. Still, if the ceiling-roof outlets be properly constructed and the regulators attached to the inlet shafts properly attended to, air-draught of this sort will be but inconsiderable. Inlets and outlets if heated should not—more particularly inlets—be made of metal, unless the heat be derived from such a source as hot water at low pressure. If there be likelihood of exceptional draught up a chimney, so as to bring about a reversal of the flow of air in an outlet shaft, the latter should be supplied with some appliance for regulating its size ; and, if there be likelihood of such draught up an outlet shaft as to cause noise, the lower opening of the shaft should be fitted with an easily removable frame filled with metallic gauze, which, under other circumstances, should be carefully avoided.

(Gas-jets to be allowed for.)

(Heating of inlets and outlets.)

In the main ward, separation-room, day-room, and nurses'-room 1 square inch of inlet area should be provided to every 21 cubic feet of space, and the same amount of outlet area to every 22 cubic feet. In all other compartments—whether kitchen, store-room, passage, corridor, or lobby—the inlets and outlets should be provided each at the rate of 1 square inch to every 20 cubic feet. In the case, however, of the lobbies to the ablution- and closet-offices at least two large-sized inlets should be provided in each side-wall, and at least two ceiling-roof outlets of the sort above described, in addition to skirting and to wall-plate holes. These lobbies may be very efficiently perflated by properly arranged louvred openings in each side wall ; but it is somewhat difficult with these openings to secure safety for the patients. It may, too, be here mentioned that, in the case of earth-closets, if the middenstead is closed in all round, and the seat is anything more than a narrow ring, or if the orifice is provided with a cover, a vertical air-flue, 4 inches in diameter, should be made to extend from the under surface of the seat to above the closet-roof, and be provided at its outer end with a fixed cowl. In calculating the size of air-shafts of course grating-bars, the web of any net or gauze, and like obstacles to the flow of air must be allowed for ; and openings that are conical or that enter into the formation of cowls must be properly related in point of size to the shafts to which they belong. The relation of the inlets to outlets with regard to position needs very careful consideration, in order that there may be constancy of flow of the air of the compartment as a whole over and about the beds from the inlets to the outlets, and indeed from one inlet or set of inlets to one outlet or set of outlets, none of the air in its passage from inlets to outlets passing over and about more than one bed or passing directly through and merely agitating on its way the air already in the compartment. It is, perhaps, needless to say that the observance of these conditions in their entirety is well-nigh impossible, but it must be attempted, and as nearly as practicable carried out. The distribution of the inlets and outlets must accordingly be so liberal that as little as possible of the compartment shall be left free of air in its passage from inlets to outlets, and that as little chance as possible shall be given for air from over and about one bed to flow over and about another. It is needless, no doubt, to remark that outlets must not be near to inlets; and that with the view to distributing the air in its passage the inlets and the outlets must be of only small sectional area, no inlet exceeding 25 and no outlet exceeding 75 or 100 square inches. Inlets should be distributed freely along at least two opposite sides of the main ward, and, where possible, of every other compartment ; and, to simplify matters, inlets should be of the same length and open all at one level, and outlets similarly should be of the same length and made to extend upwards from one level. The lower end of the outlets should in the main ward, in the passages, and lobbies be distributed in the longer central line of the ceiling ; and a similar rule should be followed for other compartments. For a small compartment, however, of which the floor area does not exceed, say, 200 feet, a chimney-shaft, of ordinary size, cowled and at all times heated, together with wall-plate holes of the kind described above, may be regarded as sufficient for outlet of air. It is well here to observe that vertical shafts in the substance of walls, unless properly cowled and heated, are not uncommonly upcast and downcast by turns ; that, when they are acting as upcast shafts, noxious and infecting materials in the air are deposited along with condensed water-vapour on their inner surfaces ; that, when they are acting as downcast shafts, these same materials are necessarily carried back into the ward; and that shafts of this description are consequently to be avoided, unless so provided as to insure a current of air outwards at all times. Moreover, long narrow shafts constructed in the substance of walls do not admit of being readily cleansed. In this connexion, too, it may be noted that a vertical outlet flue, even though well cowled, may act as a downcast if, while the outdoor air is either only slowly moving or is hot, the air column within the flue (in some cases it should be said the mass of air within the building) becomes cooled to a temperature below that of the outdoor air—an event which not infrequently happens when the flue is fixed to the outer surface or is formed within the substance of a wall not directly exposed to the sun, or when it is situated in the interior of a building so as to be sheltered from the sun.

(Sectional area of inlet and outlet shafts.)

(Relation of inlets to outlets.)

(Situation of inlets and outlets.)

(Dangerous outlets.)

It is further to be noted that with automatic ventilation there should be no opening in the floor, whether designed to act as inlet or as outlet; and that under no circumstances should any compartment of the pavilion be brought into communication with the roof-chamber, the latter being approached and ventilated independently.

It remains to be pointed out that the means provided for perflation must be under complete control; and that the means for ventilation must be such that the inmates will not be subjected to air-draught. The latter condition must be avoided. It is a source of danger to some patients even when well covered in bed, to most patients while being washed clothed or surgically dressed, to most, if not all, patients while undergoing medical examination, to convalescents while dressing and undressing, while sitting in the ward, and particularly perhaps while using the ablution- and closet-offices, and it is not unattended by danger to the nurses. To prevent air-draught about the inmates in a room at 60° F. the velocity of the air-current about them should not exceed 18 inches per second, though in other parts of the room the movement may be much more rapid without giving rise to air-draught.

Control of perflation.

Air-draught.

The methods proposed above for ventilation are, as will be seen, of an essentially automatic sort; and, no doubt, in mild if not in most climates such methods are the best. It is questionable, indeed, whether any artificial system yet proposed is altogether satisfactory. But it must be admitted that, if the inlet flues be judiciously distributed and situated, it is possible to construct extracting flues, through which

Artificial ventilation.

the air of the different compartments of a pavilion may be efficiently removed by means of fans and other appliances. In such a case, however, it is necessary to distribute the outlets liberally at different levels and in such a manner as to prevent air-draught about the inmates; and it is imperative that, if automatic ventilation cannot be at once resorted to, the extracting appliances shall be duplicated, and that the appliance lying idle shall be in readiness for immediate action, so that the work of extraction may not at any time be seriously interrupted.

Temperature.

The *temperature* of the pavilion should, as already stated, be as nearly constant as practicable. Except for special cases it should not be suffered to fall below 50° F., or to rise above 60° F. It is often said that, so long as the bedding is sufficient and appropriate, there is no need for maintaining this temperature, an extra blanket with a hot-water bottle being all that is required. It must, however, be borne in mind that equability and a certain degree of temperature are essential for recovery from certain forms of illness, such as various affections of the air-passages and exhausting diseases; and that patients, owing either to gratitude for admission to hospital or to inability by reason of illness, frequently enough do not complain, though suffering from the restlessness which is associated with coldness, and the *rationale* of which so often escapes even the experienced nurse. For the main ward warmth may be supplied from ordinary open fire-grates, or from ventilating grates, or properly constructed stoves placed preferably in the middle line of the ward. Stoves of metal are not admissible for several reasons. The grates may be placed in the side walls. If so, however, the arrangement of inlets and of outlets described above cannot be adhered to; and the size and number of the grates will need to be much larger than would be the case with centrally placed grates, in order, as regards size, to heat the ward to the same degree and, as regards number, to prevent air from about one bed passing over other beds on its way to the fire—a condition perhaps most forcibly illustrated in a long narrow ward supplied with only one grate, and that in one of the end-walls. Two double fire-grates, each facing in two directions and preferably towards the two ends of the ward, are required for a ward 100 to 120 feet in length. If, however, the warmth thus supplied be insufficient, and the distribution of warm air after the fashion already referred to as suggested by Désaguliers be thought inapplicable, then low-pressure hot-water pipes should be introduced, the pipes, as already stated, being as freely exposed and as accessible as practicable, and in no instance placed in troughs in the floor or in recesses in the walls. The warming of the ablution- and closet- offices must be carefully attended to. If the open fire-grate be used, the grate and the ash-collector below it should be removable as a whole, in order to allow of being readily cleaned. Metal stoves, as already stated, are not to be approved. This is owing to the danger from diffusion of certain gases through the metal, also from reduction of carbonic acid and semi-combustion of organic matter in the air that comes in contact with the outer surface of the metal when unduly heated. The tendency of a chimney-shaft to act as a downcast when the outdoor is warmer than the indoor air, and when artificial heat is not required, is overcome by cowling the chimney top and introducing some warming appliance, such as a gas jet, into the lower portion of the shaft. To prevent the temperature of the air of the pavilion from rising above 60° F. when the outdoor air is very hot and, so to say, stagnant—a not uncommon occurrence in tropical and semi-tropical countries—is a matter of no small difficulty if ventilation is to be as complete as it should be, but the various devices which have been adopted for coping with this difficulty cannot be dealt with here.*

(Central fire-grates.)

(Number of fire-grates.)

(Hot-water pipes.)

(Metal stoves.)

(Outlet shafts as downcasts.)

(Prevent high indoor temperature.)

Humidity of air.

It is stated above that the degree of humidity of the air supplied to the patients should not exceed certain specified limits. As a matter of fact, however, but little attempt has as yet been made to maintain the humidity of the air of wards between those limits, except where an artificial method of ventilation has been in operation; and in these cases the attempt to control the humidity and at the same time to supply fresh wholesome air has not been successful.

Light may be provided by means of electricity or of gas. If gas is used, the air supplied for its combustion must be removed at once as the combustion proceeds. A great advantage to be derived from the use of gas lies in the fact that the heat evolved in the combustion serves admirably as a motor power in carrying on ventilation.

Furniture.

Articles of furniture are to be as few as are actually required, and to be selected for their simplicity, imperviousness of surface, and ready movability. None but necessary hangings are to be introduced, unless it be readily cleaned pictures. Window-blinds must be washable. There should be no bracket, shelf, cupboard, or floor covering that is not really required; and the only floor coverings that may be introduced are such as are readily washed and disinfected. Bedsteads should be of metal, painted, varnished, enamelled, or plated; palliasses of varnished or plated wire; mattresses and beds of disinfected horse-hair, coir fibre, flock, kapok, or straw. Hair is an expensive material, and the opening up, disinfecting, and replacing of the material of a mattress filled with it requires much time, the disinfecting being conducted by means of corrosive sublimate solution. Disinfection of straw is a matter of some difficulty; if straw is used it must at least be thoroughly clean, and if not disinfected it must be renewed at frequent intervals, and certainly for each

Prevent elevation of indoor temperature when outdoor temperature is high.

* There are in this connexion certain points which may be briefly considered here. If a ward is constructed of thin walls, and especially if there is much metal or glass in the latter, the indoor air, under the circumstances now being discussed, will generally be of a higher temperature than the outdoor air; so that the usual automatic methods for admitting and for removing air are available. If the air so admitted should be of a higher temperature than desirable, cooling appliances may be used in connexion with the inlets; in which case, however, the air is best not admitted through the side walls—a matter to be referred to again below. If, on the other hand, the ward be formed of thick walls of brick, stone, concrete, or like material, the indoor air may, under the circumstances now being discussed, be cooler than the outdoor air. The latter cannot then be admitted in the usual automatic manner; and if it be admitted uncooled the indoor air will rapidly become oppressively hot. It seems, then, that the air must be cooled before being admitted; and that, if so cooled, it can be admitted automatically best by gravitation, the indoor air being allowed to escape through open windows, doors, and skirting wall-holes. As in the previous case just mentioned so in this, for avoidance of air-draught about the patients (likely to arise from admission of cold air too near to them), and of too rapid escape of the newly-admitted air from the ward, the indoor openings of the inlets are best placed at, or just below the level of, the centre or central line of the ceiling. In both cases, too, the inlet shaft may be formed after the fashion above described for the vertical ceiling-roof shaft, the upper portion of the shaft, however, for a few feet in length, being cooled, for instance, by ice or by evaporation of water at the open surface, and if need be through the external wall (specially made porous for the purpose) of a receptacle placed immediately around it in the form of a closely-fitting jacket. The indoor opening of the inlet may, as already suggested, be at or just below the level of the ceiling, or the inlet shaft may be extended into the ward for a few feet below the ceiling, the walls of the portion below the ceiling being, for instance, a thin and freely perforated cylinder, closed at the bottom, so that the incoming air may flow into the ward in numerous different directions. The application, as also the withdrawal, of the cooling influence would need to be carefully regulated from one part of the day to another, according as this influence were or were not required. It may, in passing, be also observed here that the substitution of fresh air for the air of an underground chamber, which is so frequently of a low temperature, semi-stagnant, and unwholesome, may at all seasons be effected in a similar manner, the cooled vertical inlet-shaft opening, however, into the chamber at its lowest part, so that the incoming air would, owing to its density, force out the air already in the chamber in the form of an overflow. So, too, in supplying cool air to the interior of a building unduly heated by exposure above ground, the movement of artificially-cooled air might be made to take a similar direction, doors and windows being closed, and the indoor openings of the inlets being at the floor level, and those of the outlets in the tops of the walls, in the ceiling, or the roof. In order to place the former openings at the floor level, the ceiling-roof shaft might be extended downwards to that level; but it would, perhaps, be best to construct out-of-doors an upright shaft jacketed throughout in the manner above specified, to extend this shaft underground to the centre of the floor of the chamber, and there to bring it into communication with the interior of the latter. In some cases it would, perhaps, be more advantageous to introduce the cooled air at or about the level of the ceiling, and to allow it to escape at one or more definite openings in the lower parts of the walls. This principle might, moreover, be utilized for introducing air into a compartment through the roof and ceiling when air cannot be introduced from the sides or ends; and it might, I think, be applied to the air-flushing of sewers.

fresh patient. Bedding and clothing should be of a light colour, to aid in detection of dirt. Lockers, being apt to be used for storage and for concealment of various kinds of articles, have in many hospitals been replaced by small two-shelved tables. Dressings for immediate use in the ward may be kept in a metal box divided into small compartments, and movable on noiseless wheels. The table or tables in the ward should be perfectly plain, and, if not made of impervious material, be, like other woodwork in the ward, either painted of a light colour or varnished. Bed-pans and urine-vessels should be of white glazed ware, impervious inside and out, furnished with covers of like material, and readily cleansed in every part. Bottle-shaped urinals should be of glass.

Precautions against fire.

It is not usual to employ fire-proof materials very largely in the construction of one-floored pavilions, partly owing to questions of expediency, partly owing to the facts that hospital wards in general are good fire risks, being under supervision night and day, and that in one-floored pavilions, if the means of egress are as ample and as simple and assistance is as readily obtained as should be, there is good prospect of being able to remove promptly all the patients. But ready means for egress must be provided, and, if practicable, for extinction of fire.

(Egress.)

For egress the chief doorway of the main ward should be a clear rectangular opening at least $7\frac{1}{2}$ feet wide by 9 feet, the door being formed of two leaves swinging in both directions. The doorway at the other end of the passage leading to the main ward should be similarly formed. The doorways opening into the compartments that flank the passage here referred to should be $3\frac{1}{2}$ feet wide, the doors opening only inwards into those compartments. The passage must be kept clear of obstructions. For facilitating removal of patients a low broad ambulance-stretcher on small noiseless wheels should be kept near to or in the pavilion.

(Extinction of fire.)

For extinction of fire, tanks devoted solely to the purpose are required, firmly supported on materials not likely to be seriously affected by a fire at a height sufficient to command the different parts of the building, and kept at all times full of water. The capacity of the tanks should be at the rate of at least one-eighth of a gallon to every foot of floor-area, and, if practicable, at the rate of a gallon. The descending main, which should be about 3 inches in diameter, may terminate either at about the middle of or at two or more points in the length of the pavilion, the terminal portion or portions being fitted with cocks and watertight connexions—best formed, if the hose is to be kept attached, as it should be, by screwed ends and couplings—for lengths of hose of such size, weight, and length as to be readily removed and otherwise handled by a nurse, for commanding all internal parts of the pavilion. It is well also to have one or more outdoor cocks similarly fitted, and commanding external parts of the pavilion; special draw-off cocks should also be provided for filling fire-buckets. Water for the tanks must be derived from a source likely to yield a sufficient supply. If it is derived from a public service the arrangements should be such that pressure may be obtained at the hydrants not only from the tanks but also from the public service; outdoor hydrants should be freely distributed, and both indoor and outdoor hydrants should be of the pattern adopted by the local fire brigade. Buckets also, kept at all times full of clean water and ready to hand, should be provided at the rate of about one bucket to every 250 feet of floor area.

One-floored *versus* two- or many-floored pavilions.

So far in this report the one-floored pavilion alone has been considered. Special advantages attach to the hospital of one-floored as compared with that of two- or many-floored pavilions. For instance, patients may without undergoing the fatigue of dressing be readily wheeled out into the open air; communication with the different wards is more free; and there is no question of air from a lower ward entering an upper ward. The tendency in recent years has, accordingly, been to construct by preference one-floored pavilions, especially for surgical cases, and not to construct pavilions of more than two floors.

4. *A Two- or Many-floored Pavilion.*

A two- or many-floored pavilion.

In the two- or many-floored pavilion other points of construction than those already mentioned arise for consideration. The construction should be fireproof; and special means for ingress and egress, for ventilation, and for prevention of transmission of sound from floor to floor need to be provided.

Floor-ceiling space.

If the floors are not either of fireproof or of only slowly-burning but of ordinary construction, the space between the flooring boards and the ceiling below should be left empty and be open to free perflation through grated and hooded holes in its side walls, though a layer of slag wool, silicate cotton, or other such incombustible material may be introduced, if thoroughly enclosed, for the purpose of rendering the floor sound-proof.

Ingress and egress (doors and staircase).

For ingress and egress an ample staircase of easy grade is a necessity, doorways and doors at the main entrances, and, if practicable, at other parts, being formed as in the one-floored pavilion. The *well* containing the main staircase (and the *lift*) should be formed so as to be completely independent of the rest of the pavilion, save for direct connexions at the landings and perhaps at the roof and ceiling, a broad air-disconnecting and louvred or latticed open space remaining in the side walls between the *well* and the rest of the pavilion. If the *well* is not so completely air-disconnected, particular care is needed to insure the free and constant passage of air upwards through the roof, so as to prevent entrance of lower ward air into any upper ward or *vice versâ*. It must be efficiently lighted, and exposed to free perflation. In any case it must be provided with a large cowled vertical ceiling-roof shaft; and the space under the staircase, if closed in, must be specially lighted and specially ventilated. It is best, however, for various reasons not to close in this space. The staircase should be at least 5 feet, and, if practicable, 6 feet wide. It must be formed in short straight flights consisting of not more than about twelve steps, and separated by ample rectangular landings. The steps should be *fliers*, without *nosing*, not less than a foot in the *going* (in this case the *tread*) throughout from end to end, and not more than 5 inches in the *rise;* treads, risers, and strings, if of wood, being connected by tongue and groove. Balusters should be quite plain, and a plain varnished wooden handrail should be provided at each side. Iron or very hard wood are the best materials for the staircase. If more than ten persons are accommodated above the ground-floor, it is advisable to provide an outdoor escape-landing of ample proportions from each main ward, together with an escape-staircase or -ladder. Balconies, in addition to serving as ambulatoria, serve admirably as fire-escapes, if provided with staircases or ladders, or, in the case of the first storey, if the balcony be brought into communication with a flat roof covering the outdoor connecting corridor.

Fire-extinction.

For fire extinction the amount of water stored in tanks, as already described, should be at the rate of from one to not less than one-eighth of a gallon per square foot of the total area of the several floors;

and a branch or branches from the descending water-main, which should be 3 or 4 inches in diameter, should be provided for each floor. The number of fire-buckets required per floor should be calculated on the basis already given, each floor being separately provided for.

Ventilation.

Ventilation may be supplied on the lines already set out. Inlets may be introduced for the several floors in the manner already described for a ground floor. Outlets also for two-floored pavilions may be constructed as described for one-floored pavilions, the vertical ceiling-roof shafts from the ground floor being extended vertically upwards through the body of the floor above. If this extension is objected to, or if there are more than two floors, the main wards of the floors below the uppermost one may be supplied with outlets by constructing vertical shafts outside each window-pier, and bringing each main ward into communication with those shafts by wall-holes just below the ceilings, no shaft being connected with more than one ward. Such shafts would need to be cowled, to be supplied with gas-jets for heating, and to be formed so as to admit of being readily cleaned ; and would involve the necessity or advisability of placing the inlets away from the walls and in the middle line of the ward. The outlets for other compartments than the main ward may be similarly formed. Extension of central ceiling-shafts vertically upwards from one floor through another will, of course, in many instances be unsuitable; and, if the construction of the outdoor shafts above mentioned is objected to, the shaft may be made to extend from the lateral part of the ceiling of the lower compartment alongside one of the walls of the compartment or compartments above. Lobbies to closets and lavatories have recently been provided with air-outlets into large spaces left open between the roof of one lobby and the floor of another above it.

Warming.

The warming of upper floors may be conducted in the same manner as that described for the one-floored pavilion.

5. *Special Wards.*

Special wards.

Such, then, are the parts of the pavilion constructed for ordinary medical and surgical cases. It should be stated that yet other points of construction arise for consideration in providing accommodation for diseases of women, for confinements, for diseases of the eye, for persons suffering from scpticæmia, erysipelas, or other such disease, for refractory and for foul-smelling patients. Also, it should be noted that quarantining rooms are required for ordinary infectious diseases ; for, though the treatment of persons suffering from such diseases on the grounds of a general hospital on a large scale cannot be approved, seeing that the complete isolation and independent administration required are so difficult of accomplishment, there are cases in which the diagnosis at the time of admission is obscure, and others in which the infectiousness of the patient is discovered or develops only after admission, and at a time when removal to an isolation-hospital cannot at once be carried out. Quarantining rooms are, in fact, required for at least one male and one female while affected by any one of three different infectious diseases; so that in connexion with a large general hospital there should be, in all, six beds for patients, together with accommodation for nurses in three separately isolated buildings, together with a small administrative building.

6. *Arrangement of Buildings of a General Hospital.*

Plan of hospital.

Attention may now be directed to the arrangement of the pavilions and other buildings which enter into the constitution of a general hospital. This will, of course, vary with the shape of the site available. If the shape permits, it is well for observance of conditions which have been set out above, and for convenience of administration, to distribute the pavilions in equal numbers on the two sides of the administrative buildings, placing their long axes parallel one to another, and, unless there be special reason to the contrary, in the line of the prevailing wind and of the sun's rays, and supplying approaches to their main entrances from one common broad slightly-raised impervious path, roofed over at a height not exceeding 12 feet, and enclosed in no way at the sides. If the climate is so very inclement as to forbid such openness of the corridor the latter is closed in at the sides, air-disconnected, however, from the buildings between which it lies, and well provided with means for perflation, lighting, ventilation, and, if need be, for warming. The sides are best constructed in chief part of large readily removable sash-doors, extending from floor to roof of the corridor. The interval between the administration-block and the nearest pavilion on either side, as also that between the several pavilions, should be two or three times the height to which either of the two buildings concerned is likely to be built, or in the case of many-floored pavilions even longer. If there are more than four pavilions they may be arranged in two rows one behind the other, and at a distance apart of about 100 yards, the axes of the pavilions of the one row being in line with those of the other. As already intimated, it is not always either possible or advisable to place the axes of the pavilions in the line of the prevailing wind; in tropical latitudes it may indeed be advisable to place the pavilions broadside to the prevailing wind, in order to secure as much natural perflation of the interior as possible.

Of the administrative buildings, which may be placed between the two central pavilions, mention may be made of the receiving-rooms for the patients, the surgeries, the apartments for the resident medical staff, the day-room for medical students, and the offices of the managers, of the steward, and matron, together with the dispensary and the operating theatre, and well to the rear the kitchen. The steward, matron, nurses, wardmaids, and (separately) the outdoor labourers should be accommodated in buildings altogether away from the pavilions; and such buildings as the laundry, bath-house, disinfecting, incinerating, and *post-mortem* or pathological rooms, the ambulance sheds and stables, and the workshop must also be well removed from them. Any out-patient department of even moderate dimensions must be apart to itself. The more precise situation of these and other buildings constituting the general hospital can be determined only when the site and its surroundings are known.

In order to deal promptly with fires, it is necessary to provide the administrative buildings with appliances such as have been described for the pavilions, to provide also fire-alarms, means for ready communication between the different buildings and with the nearest fire-brigade or police station, a liberal supply of indoor and outdoor fire-hydrants so as if practicable to command all the buildings, and, if necessary, a fire-engine. It is well, also, to institute a system of fire-drills.

7. *Water, Disinfection, Removal of Refuse Matters, and Drainage.*

Water.

Water in liberal amount and constantly supplied, with hot and cold services, is an essential. If there is reason for apprehension as to the wholesomeness of the water, provision must be made for sterilizing it by boiling or by passing it through such a filter as that of Jeffrey or of Chamberland-Pasteur.

And here it may be observed that sterilization of water used in the dispensary, whether for medicines, for irrigation purposes, or for dressings, is to be carefully observed. Tanks supplying water to closets, baths, sinks, urinals, or drains must be kept wholly independent of those supplying water for drinking or for dispensary purposes.

Disinfection.

Provision must also be made for thoroughly disinfecting all kinds of articles of clothing and bedding used in the hospital. And it may, in passing, be observed that, if the grounds are limited, it is well to draw through fire the vapours from such buildings as the kitchen, the laundry, the morgue, *post-mortem* room, dissecting room, and out-patient room.

Removal of refuse matters and drainage.

The removal of all refuse matters right away from the precincts of the hospital, or the destruction of them in an innocuous manner and as rapidly as practicable, is essential. If it is necessary to deliver them into street gutters, solid excreta must, of course, be excluded from them ; and first they must be thoroughly disinfected, and they should be cleansed by such a process as irrigation on land at a distance from the hospital. All receptacles and conduits for refuse matters of any sort must have smooth, hard impervious interiors, and be frequently cleaused. Drains must be flushed regularly from tanks devoted solely to this purpose. All indoor receptacles delivering these matters into outdoor drains must deliver them through pipes that are trapped (the bell-trap in all instances being avoided), short, and readily accessible ; shortness of these pipes necessitating the placing of indoor siuks, urinals, closets, and lavatories near to external walls. The refuse matters so delivered to the exterior, as also rain from downspouts and overflow- and waste-water from water tanks and pipes, must in all cases be received at the ground level on short impervious open gutters about 18 inches long, the gutter in turn delivering through a self-cleansing well sealed trap, or, in the ease of the sink-pipe from a large kitchen or scullery, through a proper grease-trap into an underground draiu. This mode of delivery into an underground drain is to be modified only in connexion with the water-closet, the soil-pipe from which, extending in as short a course as may be to the exterior, is then to be continued as a four-inch pipe throughout, on the one hand downwards to the ground level, and then, after a short course underground, through a properly-constructed trap into the above-mentioned underground drain ; and, on the other hand upwards into a ventilatiug shaft extending to a point above the eaves, and at a proper distance from any window or chimney, a special opening * into the pipe or, better, another vertical ventilating shaft being supplied near to and on the closet side of the trap just mentioned. The ventilating shaft or shafts need to be properly cowled, the soil-pipe needs to be provided with inspection-covers, and the siphonage of traps needs to be guarded against by ventilation of them. The underground drain, which must present a smooth impervious interior and an uninterrupted bore, must be laid on a firm foundation to a self-cleansing grade if practicable, and in straight lines, all junctions of different drains one with another being properly curved. It must be provided with probing-shafts at intervals of about one chain, and at every chauge of direction and of gradient. If the drain is more than, say, a hundred yards long, or if it delivers into any eovered sewer, it should be provided immediately below the trap above mentioned with a properly sealed ventilatiug shaft, 4 inches in diameter, and extending upwards like, and if thought well, communicating with one of the ventilating shafts for the soil-pipe. If the drainage system be underground, provision should be made for entirely cutting off any part or the whole of the system from the hospital, so that when wards *lie fallow* there may be no escape of sewer air into them through traps from which the water-seal has evaporated. If it is out of the question to construct an underground drain, an open drain will be required, and it will need to be constructed similarly to, though of greater width than, the invert of the underground drain above mentioned. Prompt removal of rain water falling on the site must be provided for by an effective system of surface and if practicable underground drainage ; and it is well to render impervious the surface for some feet beyond the walls. If earth-closets are used, they must be on the double system, the pans being frequently removed and cleansed, and deodorant being regularly applied. An earth-closet on the single system and near to the ward is a source of the gravest mischief. If there is no underground drainage system by which liquid refuse may be removed right away from the hospital, then all urine, the contents of bed-pans and of other ward-utensils, and the washings of the *post-mortem* room must be received in separate receptacles of white glazed ware and removed at frequent intervals, at least daily. The contents of bed-pans and of ward-urinals should not be kept in the closet-office, so that the washing of these utensils is best conducted at a distance from the ward and by a labourer appointed for the purpose.

B.—Large General Hospitals of Gradual Growth, and Small General Hospitals.

Hospitals of gradual growth.

So far, this report has dealt only with complete large general hospitals. There are, however, numerous growing communities for which it is desirable to provide merely for immediate, and at first small, requirements ; and at the same time, though adding to the accommodation as need arises, to provide from the outset all the requirements of hospital hygiene.

A scheme such as the following would, I think, meet these cases :—In the first instance, a one-floored pavilion is constructed of the general shape of that portion of the pavilion referred to in what has gone before as the main ward, though differing from the latter in being furnished with a lavatory- and a closet-office at each end. Two independent wards, one for males and the other for females, and one towards either end of the pavilion, are then formed by the introduction of two compartments (a nurse's room and a ward scullery) towards the middle of its length, the partitions required for this purpose being so constructed that they may be readily removed at a later date. This doubly warded pavilion is placed on the site in such a position that it will later occupy one side of a rectangular area, situate somewhat in front of the centre of the grounds, and the opposite side of which is to be formed by another similar pavilion, to be erected later parallel to that first erected. On a line parallel to these two pavilions, and equally distant from either, a row of buildings is erected, comprising—in front, the dispensary and store-room; behind these an entirely isolated operating theatre; and, further to the rear, the kitchen and scullery. Behind the rectangular area there are erected wash-house, disinfecting-room, morgue, and so on ; and, in front of it, the buildings for a resident surgeon, a steward, and a matron, the latter buildings being at such a distance in front of the rectangular area as to allow in the interval between them and the latter area at a future period of the addition (to each of the pavilions) not only of the *office-block* which, as stated above, forms part of a completely equipped pavilion, but also of the introduction of a straight slightly raised footpath giving approach to the different pavilions.

* These openings into the pipe very commonly serve as outlets, and should therefore not be used except under special circumstances.

When need for accommodation increases, the second doubly warded pavilion above mentioned is erected, so that at that date surgical and medical patients may be separated. With need for further accommodation other similar pavilions are erected to right and left of those already on the ground ; and then, if thought well, the partitions above spoken of, together with the lavatory- and closet-offices at the front end of the pavilions, may be removed. The *office-block* above mentioned and the footpath or outdoor corridor may be added, and the whole of each pavilion be then devoted to one class of cases. It may, in passing, be noted that, in erecting the *office-block*, it is best to place it a few feet from the pavilion, and to connect it with the latter by an air-disconnecting lobby, not only for prevention of disturbance by settlement but also for facilitation of indoor perflation and ventilation.

A scheme of this sort I suggested on a previous occasion as likely to serve well for growing requirements in connexion with an isolation-hospital for infectious diseases, each doubly-warded pavilion sufficing for isolation of males and females while suffering from one kind of infectious disease. If the scheme set out above for a general hospital is considered too ambitious for a particular locality, there being but little prospect of any large hospital being required for many years, it may be well to build a small administrative block containing from four to eight rooms, and, on each side of and separated from it by an air-disconnecting passage of about 12 feet in length, a small ward ; an operating theatre being erected to the rear of the administrative block, and still further to the rear any other necessary buildings. Houses have been utilized as hospitals for as many as twenty and more patients ; and, no doubt, if they are well exposed to the sun and air and managed properly, the best results may be obtained in them. The hygiene of small cottage hospitals should not present any difficulty. Huts and tents cannot be recommended unless it be for merely temporary and special purposes, and in mild weather.

Small hospitals.

C.—Some Particulars of Management.

Management in preserving wholesomeness and in preventing infection.

A few remarks may now be made on certain matters of management affecting the wholesomeness of the ward, and the non-transmission of infection in a general hospital. In the first place it may be well to refer to certain of the precautions taken with the latter objects in view in properly managed hospitals devoted to isolation of persons suffering from infectious disease. In the latter hospitals the patient, on arrival in the receiving-room, is placed on a low noiselessly-wheeling broad stretcher ; the nature of the disease is diagnosed ; the patient is dressed in a hospital jersey and nightgown, wrapped round in a hospital blanket, and removed to the ward; while all articles (clothing, bedding, and other) brought to the hospital with the patient are at once removed to the disinfecting-room, whence, when thoroughly disinfected, they are removed and stored in a special room until either required by the patient when leaving the hospital or, in the event of death, removed by the patient's friends. The bed-linen, blankets and coverlets, the mattresses and beds, are frequently disinfected. The patient drinks from no vessel and uses no towel which has been used by another patient, unless it have first been cleansed. When the patient is *getting about* again a special hospital dress is worn ; and when about to leave the hospital the patient dresses in a special *discharging-room* in the clothing brought at the time of admission and since disinfected, the clothing worn by the patient while in hospital being at once removed and disinfected. The doctor, the matron, the nurses, and the ward-maids wear only such outer clothing as can be readily washed and disinfected ; and the latter processes are carried out at frequent intervals. The doctor and the matron, in moving from ward to ward devoted to different classes of infectious illness, put on cloaks specially set apart for the particular ward about to be entered and wash their hands in a disinfecting solution. Nurses also, when transferred from one ward to another containing a different class of case, put on newly-disinfected clothing. The visiting of patients by relatives and friends is limited as much as possible. Surgical instruments are all sterilized according to their nature in boiling water, in alcohol, or in a solution of corrosive sublimate immediately before and immediately after being used; and the wards are completely washed out from time to time. The internal surfaces and articles of furniture are frequently dusted over with a damp cloth. Oil-painting of the walls and ceilings is carried out with considerable frequency. Ice for the patients, so much used in these hospitals, is never kept, as it so frequently is in other hospitals, in the ablution- or closet-office. And all the soiled articles of bedding and clothing are at once removed to the disinfecting tanks.

If the diagnosis on admission is obscure, if the case is foul smelling, or if the patient develops another infectious disease after admission, the patient is treated in a one-bedded and well-isolated ward.

The precautions above mentioned are essential to the management of an isolation-hospital ; and not a few of them might with advantage be copied in the management of other kinds of hospitals.

Nursing.

A few observations may now be made concerning the nursing staff. The nurse, in the interests alike of herself and of her patients, must not, above all things, be overworked. The over-wrought nurse constitutes a grave reflection on the hospital management, being evidence of cruel hardship on the part of those in authority over her, and a source of untold mischief to the patients she is supposed to be tending. Ample provision for outdoor and for indoor recreation and liberality in the matter of holidays are essential to the proper discharge of her duties in the ward. Her illnesses also need to be specially recorded in the Nurses' Sick-book. The nurse, moreover, needs to be trained to her office in a systematic manner, if she is to realize and to act up to the responsibility she is to undertake ; and no large general hospital should be without its complete nurses' curriculum. In this connexion, too, I would draw attention to one particular duty of the nurse, which is of no small importance, especially in localities where typhoid fever prevails. I refer to the mode of handling of bed-pans, the cleansing of them, and the immediate application of an effectual disinfectant to stains on articles of bedding (and clothing) from the stools of patients. These duties are of peculiar importance, because the neglect of them is attended by serious risks. And yet, though the risks are so serious, the nurse is but rarely instructed how to prevent them, or indeed furnished with the appliances necessary for this purpose. The risks, here referred to, are moreover enhanced in hospitals where soil-pipe air from water-closets is allowed to enter the closet-office, and in other hospitals where, in the absence of an underground system of drainage, either the disgusting single-pan service is in use or the slop-sink, in which the contents of the bed-pan are emptied, is unprovided with a trapped outlet and with proper flushing apparatus, and is nevertheless kept in the closet-office.

It remains to be stated that if there is an out-patient department on the grounds, or an outdoor medical relief department for cases of confinement, of illness, or of injury, the administration of such department should be entirely independent of that directed to indoor patients. If there is a school of

medicine connected with the hospital, the students should not, except under carefully-regulated conditions, attend in the *post-mortem* or dissecting rooms while attending on cases of confinement, of injury, or of operation.

The general considerations set out above as to principles of hospital-construction will now be turned to account in considering the degree of wholesomeness of the conditions met with in the hospitals of this metropolis. To a consideration of this I shall now proceed, taking first the general and then the special hospitals, and, first of all, the Melbourne Hospital—premising however, at the outset, that, much as it may be desired to secure an ideal site for a hospital, it is only rarely that this can be accomplished, and that in all instances, where a large general hospital is located amid conditions which are not satisfactory, a home for convalescents should be established elsewhere amid conditions as wholesome as can be secured.

D. ASTLEY GRESSWELL,
M.A., M.D., Oxon.

By Authority: Robt. S. Brain, Government Printer, Melbourne.